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SUPERSONIC CAPABILITY OF PRATT AND WHITNEY TURBOJET POWER PLANTS

P. G. Thome
AIRCRAFT APPLICATIONS UNIT

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GENERAL ELECTRIC
ATOMIC PRODUCTS DIVISION
AIRCRAFT NUCLEAR PROPULSION DEPARTMENT
Cincinnati 15, Ohio

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SUPERSONIC CAPABILITY OF PRATT & WHITNEY
TURBOJET POWER PLANTS

March 22, 1960

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APPLICATIONS TECHNICAL ANALYSIS

Reference A: XDCL 60-3-18, "Summary of Pratt & Whitney Applications Studies," W. J. Tripp

At the request of Mr. A. A. Hafer an analysis was made of the supersonic capability of Pratt & Whitney turbojet power plants. Brief descriptions of these power plants have appeared in various Pratt & Whitney quarterly reports and are summarized in Reference A. However in most cases, Pratt & Whitney does not present results of application studies setting forth the resulting airplane performance capability. They merely quote power plant weight and thrust for specific altitudes and speeds. Therefore, an analysis was made to determine the performance capability of airplanes powered by these power plants. It is not the purpose of this report to assess the reasonableness of the power plant weight and thrust levels quoted.

Figure 1 of Reference A lists twelve turbojet power plants. Of these, numbers four to nine are listed as being designed for supersonic bombers. According to the information in PWAC 584 and PWAC 593, power plants number four and seven are virtually the same except for an unexplainable difference in weight. Since power plant number four listed in PWAC 593 is more recent it was assumed that the power plant number seven is obsolete and hence was not considered.

Portions of Figure 1 of Reference A are presented on the following page together with the estimated airplane cruise weight and performance.

Power Plant Number Four - This power plant is a lithium-Nak system with a turbine inlet temperature of approximately 1550°F. (It is assumed that there is a 100°F drop between radiator inlet and turbine inlet temperature). At this temperature the thrust is sufficient to fly the airplane only at subsonic speeds. Supersonic performance is obtained by chemical augmentation with the thrust quoted in Figure 1 of Reference A sufficient to fly the airplane at M = 3 and 65,000 feet if only landing fuel is on board. If 100,000 pounds of fuel is added the airplane would have a capability of M = 2-2.5 for a range of the order of 500 miles. It is to be observed that this power plant is essentially designed for the WS125A, cruise-sprint-cruise type mission.

PRATT & WHITNEY TURBOJETS

		(4)*	(5)	(6)	(9)
1.	Application	Supersonic Bomber	Supersonic Bomber	Supersonic Bomber	Supersonic Bomber
2.	No. of Reactors	1	1	1	1
3.	Reactor Type	Moderated	Moderated	Moderated	Fast
4.	Primary Coolant	Lithium	Lithium	Lithium	Sodium
5.	Secondary Coolant	NaK	None	None	None
6.	Total Reactor Power (MW)	350	350	575	350
7.	Reactor Out Temperature °F	1750	1750	2000	1650
8.	Radiator Inlet Temperature °F	1650	1750	2000	1650
9.	Nuclear Engine Type	J-58	J-58	?	J-91
10.	Number of Engines	6	6	6	4
11.	Total SLS Airflow (lb/sec)	1800	1800	1980	1600
12.	Total Power Plant Weight (lb) (including dry crew shield)	189,300	152,300	154,900	140,300
13.	Dose Rate (Rem/hr)	.03	.03	.03	1.5
14.	Design Flight Capability Mach Number Altitude	 .9 25,000	 2.4 45,000	 3.0 55,000	 2.0 38,000
15.	Gross Weight (Incl. Landing Fuel on Board)	426,000	372,000	375,000	[illegible],000
16.	Payload	30,000	30,000	30,000	1[illegible],000

*Numbers refer to power plant numbers in Figure 1, Reference A

Power Plant Number Five - This power plant is an all lithium system with a turbine inlet temperature of approximately 1650°F. This power plant has the capability of attaining M = 2.4 at 45,000 feet on nuclear power with a payload of 30,000 pounds. This performance capability is based upon an estimated thrust of 10,500 pounds for the J-58 at this flight condition. (This estimate was made by Mr. J. R. Geyer of JED). The gross weight of 372,000 pounds is the supersonic cruise weight, since not enough information is known about the power plant to determine the climb and acceleration fuel requirements. With chemical augmentation the power plant is capable of powering an airplane at M = 3.0 and 65,000 feet. However, not enough information is available to estimate the range at this condition.

Power Plant Number Six - This power plant has a Mach 3 all-nuclear capability with a turbine inlet temperature of approximately 1900°F. Here again only the supersonic cruise weight is quoted.

Power Plant Number Nine - This power plant yields the lightest airplane but with only one-third of the payload of the others, namely 10,000 pounds. This power plant has the capability of M = 2 at 38,000 feet on all-nuclear power at a turbine inlet temperature of 1550°F.

Power Plant Number Eight in Figure 1 of Reference A does not have sufficient thrust to fly at M = 3.5 as quoted. However since the engine characteristics are not given, it is not possible to determine what the airplane performance would be.

The performance estimates given above are based upon structural weight fractions and lift-to-drag ratios comparable to the B-70 for Mach 3 designs. Lower design Mach numbers have somewhat higher lift-to-drag ratios and lower structural weight fractions.

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